segments have a dipole component, the following two segments have no dipole component, and the last two segments have a dipole component 180° out of phase relative to the dipole component of the two segments. The dipole ratio is η=100% and the mean free path is 1 mm. FIG. 5-C shows computed trajectories for number of ions entering the ion guide of FIG. 5-B, for varying entrance positions, initial angles, and initial starting times to relative to the RF guiding field phase.

FIG. 5-D shows a computed trajectory for a single ion entering a structure similar to that of FIG. 5-A, with the dipole generator V_{rf3} present ($V_{rf3}=V_{rf1}$ and η=100%) for all guide segments following the first guide segment, and a mean free path of 1 mm. No dipole voltage is applied to the first guide segment. As illustrated, the ion trajectory is displaced from the geometric axis of the guide after the first guide segment, and the ion exits through the outlet aperture aligned with the central field axis.

FIG. 5-E shows computed trajectories for a distribution of ions entering the structure of FIG. 5-D, without the dipole generator V_{rf3}. The ions were distributed across the skimmer hole and with a small angular spread about a nominal angle of 6 degrees with respect to the axis of the structure. The ions entered the structure at random RF phases. FIG. 5-F shows the trajectory of a distribution of ions entering the structure of FIG. 5-E, but with the dipole generator V_{rf3} present ($V_{rf3}=V_{rf1}$). FIG. 5-G illustrates the effect of lowering the gas pressure in the guide structure of FIG. 5-F to a mean free path of 10 mm. Many of the ions are lost due to collisions with the guide plates before the ions encounter the conductance aperture at the exit, because of insufficient collision cooling and the large displacement of the ions towards the electrodes by the dipole field.

FIG. 5-H shows computed trajectories for a distribution of ions entering a structure similar to the one shown in FIG. 5-D, but with a zero entrance angle (i.e. the inlet aperture oriented exactly along the central geometric axis}. The mean free path is 1 mm. FIG. 5-1 shows computed trajectories for a distribution of ions entering a collision cell having a guiding field axis distribution similar to the one shown in FIG. 4-A, with a progressively narrowing spacing between the guide electrodes. The middle two segments in FIG. 5-I generate no dipole electric field. FIG. 5-J illustrates computed trajectories for a guide such as the one shown in FIG. 5-A, employed as an ion gate. The gate is closed by reversing the phase on the inlet and outlet guide segments. Reversing the phase subjects incoming ions to fringe fields acting as a barrier, rather than to the center of the restoring field. No dipole is applied, and the mean free path is 4 mm.

FIG. 5-K shows computed displacements caused by a dipole field component for a group of ions, for flat plate electrodes and a mean free path of 4 mm. FIG. 5-L shows computed displacements caused by a dipole field component for a group of ions, for continuous, cylindrical rod electrodes and a mean free path of 4 mm. A comparison of FIGS. 5-K and 5-L reveals that the magnitude of the displacement is smaller for the round rod configuration than for the flat plate configuration; and that many ions strike the electrodes and are lost in the round rod configuration. These effects are due to the greater deviation from an ideal dipole in the round rod configuration. The deviation increases as the displacement from the center increases.

FIGS. 6-A and 6-B show two equipotential surfaces perpendicular to the dipole electric fields, computed for flat plate and round rod configuration, respectively. As illustrated, the flat plate configuration generates a relatively uniform dipole electric field.

It will be clear to one skilled in the art that the above embodiments may be altered in many ways without departing from the scope of the invention. Accordingly, the scope of the invention should be determined by the following claims and their legal equivalents.

What is claimed is:

1. A mass spectrometry apparatus comprising:

an ionization chamber for forming ions of interest;

a guide chamber having an inlet aperture in communication with the ionization chamber, and an outlet aperture, wherein a central axis of the outlet aperture is displaced from a central axis of the inlet aperture;

an electrodynamic ion guide positioned in the guide chamber, for guiding ions from the inlet aperture to the outlet aperture, the ion guide comprising

an inlet guide section for generating a first electrodynamic ion guiding field having a first generally longitudinal central field axis, situated such that ions transmitted through the inlet aperture enter the inlet guide section substantially along the first central field axis;

an outlet guide section longitudinally concatenated with the inlet guide section, for generating a second electrodynamic ion guiding field having a second generally longitudinal central field axis displaced from the first central field axis and substantially aligned with the outlet aperture;

a mass analyzer in communication with the outlet aperture, for receiving ions exiting the guide chamber through the outlet aperture; and

an ion detector in communication with the mass analyzer, for receiving ions transmitted by the mass analyzer.

2. The apparatus of claim 1, wherein:

the inlet guide section comprises a first plurality of quadrupole electrodes disposed symmetrically about a longitudinal, central geometric axis; and

the outlet guide section comprises a second plurality of quadrupole electrodes disposed symmetrically about the central geometric axis.

3. The apparatus of claim 2, wherein the first field axis substantially coincides with the central geometric axis.

4. The apparatus of claim 1, wherein:

the first guiding field has a quadrupole component; and

the second guiding field is an asymmetric guiding field having a quadrupole component and a dipole component.

5. The apparatus of claim 4, wherein the first guiding field is a symmetric quadrupole field.

6. The apparatus of claim 1, further comprising:

a first voltage source coupled to the inlet guide section, for applying a first quadrupole voltage set to the inlet guide section to generate the first guiding field, wherein the first guiding field is a symmetric quadrupole field; and

a second voltage source coupled to the outlet guide section, for applying a second voltage set to the outlet guide section, the second voltage set comprising

a quadrupole component for generating a symmetric quadrupole field component of the second guiding field, and

a dipole component for generating a dipole field component of the second guiding field.

7. The apparatus of claim 6, wherein the first voltage source comprises a pair of leads of a secondary inductor of a transformer, wherein a first lead of the pair of leads is